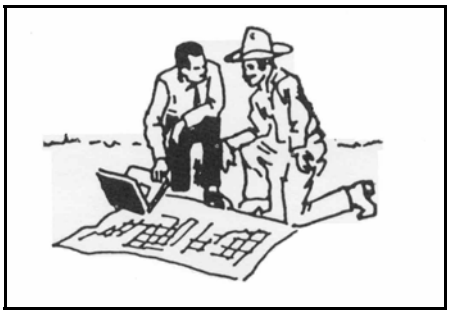
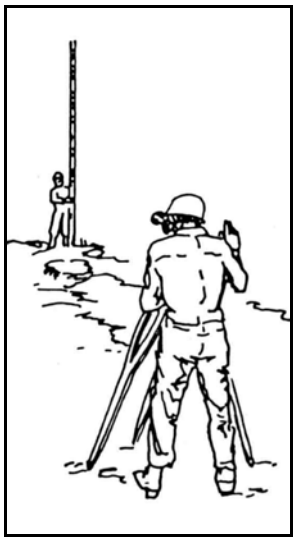
The ABC's of Seismic Exploration for the Private Landowner and Public Land Administrator

Elements of Seismic Operations as they pass through your area...

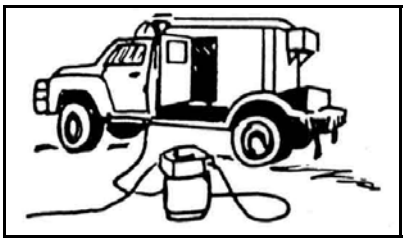


1. The first representative of a seismic operation you may meet is the permit agent, who obtains the permission required to conduct a seismic operation in your area. If this is to be on private land, permission is obtained from the landowner. If it's to be along roads or on public lands, permission is obtained from a government agency and, where appropriate, adjacent landowners. The permit agent reports back general information to the seismic crew and provides them with agreements made in new areas. Some-times, the permit agent travels hundreds of miles a day and may be days or weeks ahead of the actual seismic operation. Any fees paid by seismic companies are to compensate for any disruption of the landowner's activities or for temporary surface disturbance caused by the crew. These fees are negotiated between the two parties.

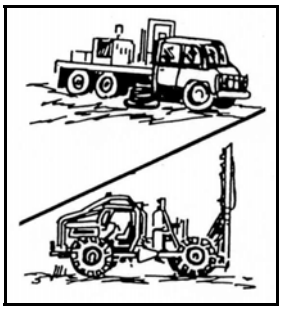


2. The survey crew marks the exact route the seismic line will take. The survey crew also measures surface elevations along the line and specifies the points where sound waves will be generated and listening devices placed.

3. Following the surveyors, another part of the instrument crew lays out sensitive listening devices along the seismic line. These "geophones" pick up the reflected sound waves after they have been weakened by passing through miles of underground rocks. The geophone converts these signals into electric impulses which are transmitted by cable to the recording truck. Inside the truck are delicate electronic instruments which amplify and record the electric impulses for later computer analysis. Geophones and recording instruments are so sensitive they can pick up footsteps scores of feet away.



4. There are several ways to generate seismic sound waves into the ground. Surface detonations, shot hole detonations, vibroseis, (vibrator pad) and air guns are commonly used methods to generate seismic sound waves into the ground.



5. While seismic crews move rapidly from area to area, they exercise care to clean up along the seismic line so the area is left as near to its original condition as possible. The permit agent or another representative of the crew will coordinate this effort to make sure that all the terms of the permit have been satisfied.

SEISMIC ENERGY SOURCES ...AND WHY THEY VARY

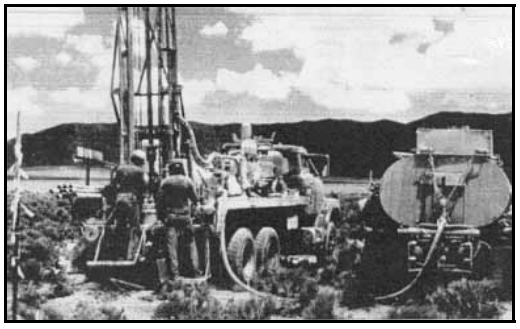
Illustrated on these pages are the four most common methods for generating sound waves for land seismic exploration: surface detonations, traditional shot hole operations, the vibrating energy source, and the air gun. Factors that influence the selection of a particular method include prior experience, environmental concerns, and economics. Exploration companies must have flexibility in selecting the best method to ensure they obtain the highest quality geophysical data possible.

Surface Detonations

Often specified by government permitting agencies in remote areas, generally away from people, is the "surface shooting" method. This is usually a portable operation, with helicopters used to transport workers and equipment along the survey line (avoiding the use of motorized vehicles and ensuring minimum impact on the land).

Small charges are mounted on wooden stakes several feet above the ground in a pattern that could include from one to a dozen charges at each shot point. The detonation of these surface charges can be heard for considerable distance, depending on surface terrain, weather conditions and other factors. However, the sound level is relatively low and incidences of actual physical damage or serious disturbance of wildlife are extremely rare.

Traditional Shot Hole Operations



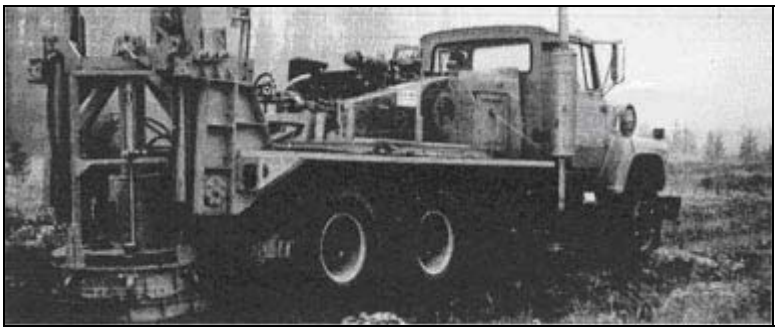
In this method, a hole is drilled and an explosive charge is buried. Detonation of the buried charge creates a seismic sound wave. The typical seismic shot hole ranges from 10 to 200 feet in depth and is about four inches in diameter. Detonations are usually contained within the hole to force the energy generated downward through various rock strata, and the only sound heard above ground is a dull thud.

This operation involves a drilling crew, motorized vehicles, a crew for detonation, a shot hole plugging crew (seismic shot holes must be properly plugged in a manner specified by state and/or federal government agencies), and clean-up personnel.

Vibrating Energy Source

The vibroseis method involves surface vibration rather than detonations. A specially designed vibrator pad, mounted below a vehicle, is compressed against the ground and vibrated at regular intervals to create sound waves. Damage to the ground by the vibrator pad is minimal. Several of these vehicles operate together to form the energy source. Difficult terrain often limits the use of this particular seismic energy source.

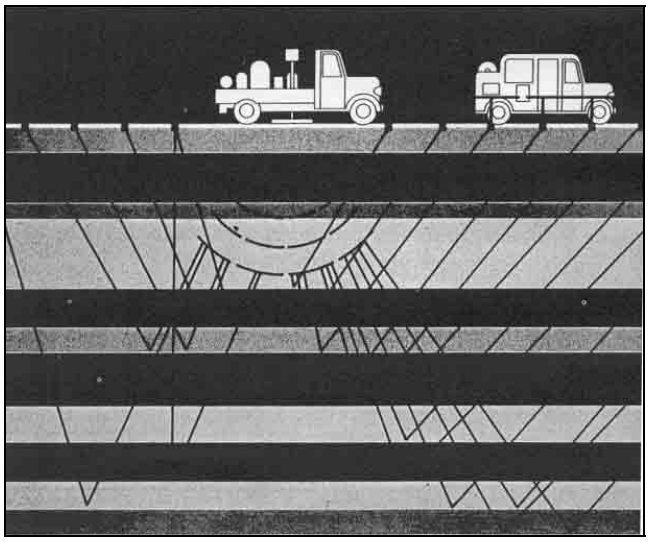
Air Gun Operations



An air gun is a truck or tractor-mounted seismic source that uses compressed air. The air gun is contained inside a bag filled with water and discharges compressed air, which generates the seismic sound waves. The air gun bag is mounted on the back of the trucks as shown in the photograph. Damage to the ground by the bag is minimal. One to four air gun trucks operate together for most seismic exploration work. This source is also limited by terrain and data quality considerations.

An example of the seismic method is shown below. A vibrator truck (left) generates sound waves which penetrate the earth. These waves pass through the various rock layers and are eventually reflected back to the earth's surface. At the surface, the reflected waves are received by the geophones, converted to electrical impulses and transmitted to a second truck. The second truck (right) "records" the electrical impulses on magnetic tape as seismograms. After the crews have completed their work, the collected subsurface data are processed and analyzed on computers to determine the area's potential for oil and gas production.

With your cooperation...



At present, our country depends on foreign imports for a significant portion of the oil and gas needed to heat and cool our homes, power our autos, generate our electricity, fuel our factories, and provide the raw material for many chemicals, plastics, fibers for clothes, cosmetics, and other products. This dependence threatens our security and drains dollars from our domestic economy.

We desperately need to find additional domestic crude oil and natural gas to achieve energy independence. We need your help in doing just that. U. S. petroleum companies are conducting an intensive, nationwide search for additional oil and gas - a search that now extends to your area.